



HIGHLIGHTS

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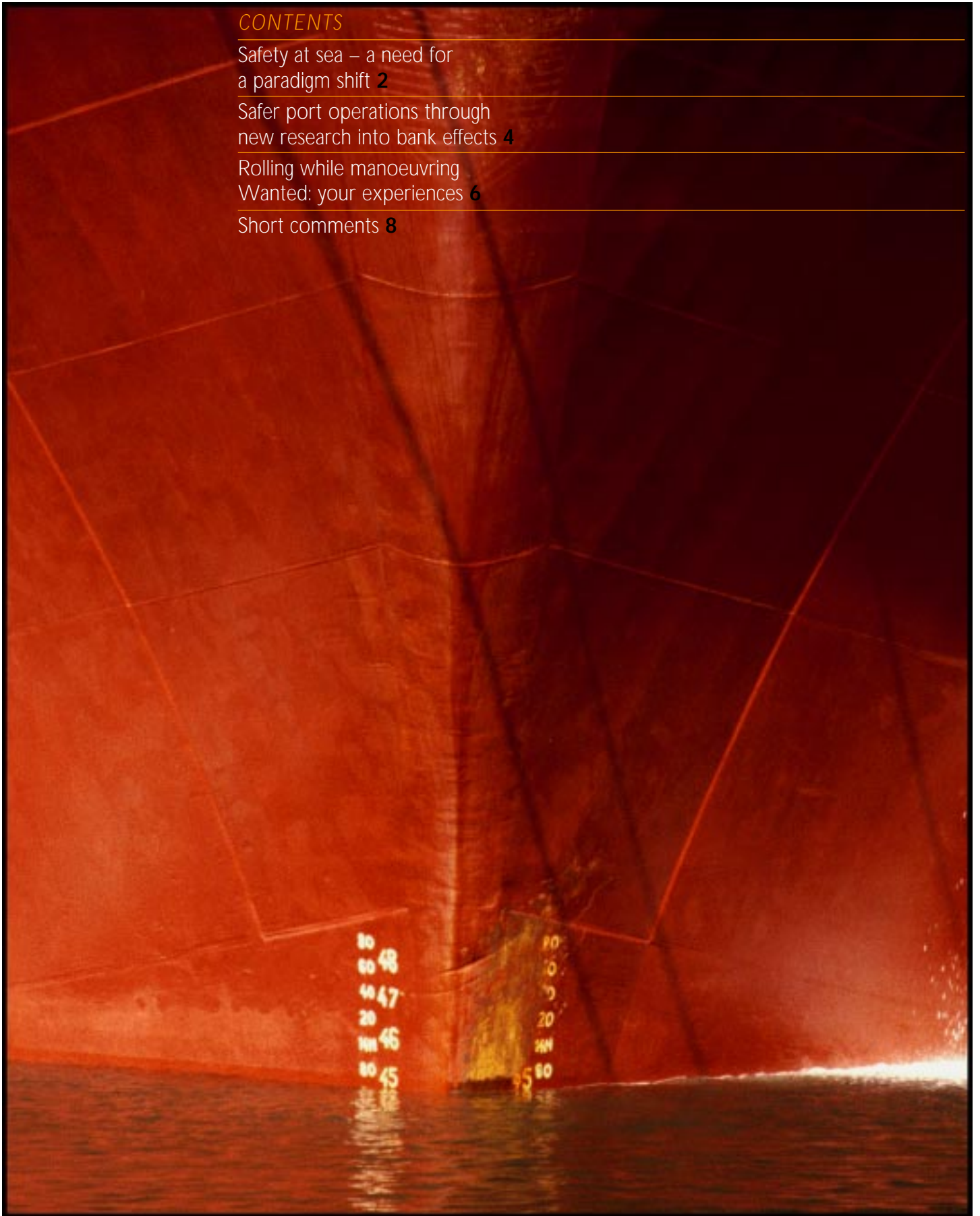


PHOTO: JOACHIM AFFELDT



Safety at sea – a need for a paradigm shift



Has shipping safety culture developed as much as ships from the 19th to the 21st century??

To have the customers' confidence is invaluable. Customers want their goods to arrive at the right time and in perfect condition. Passengers choose the carrier in which they have confidence regarding comfort, safety and punctuality.

These are well-known and unquestioned messages. And still – the same messages have appeared in magazines for decades, but have resulted in only minor improvements.

We still have good reasons to repeat the demand for improved safety, less damage of goods and better regularity.

It is high time to act, probably without waiting for international regulations and agreements. It is time to market the concept of customer confidence.

LARS AFZELIUS

Safety at sea has been improved considerably by new rules – SOLAS – and technology. Still there is a lot to be done and lessons to be learned. We have to be more conscious of how to avoid accidents instead of just mitigating consequences. We have to determine which factors contribute to the occurrence of accidents, and we have to learn from other areas such as the aircraft and nuclear industries.

The sea transport industry has created an impressive system of rules – SOLAS, MARPOL etc – to assure that sea transport is safe and does not have a harmful impact on the environment. Nevertheless a large number of accidents happen, which result in casualties and negative consequences for the environment. Accidents are the main reason for changing the rules. Thus most changes of the rules affecting sea safety are reactive responses to accidents. A proactive approach is seldom used, and if so, the changes are often based on spectacular measures rather than founded on objective studies. The reasons are quite obvious, as it is difficult to quantify effective measures to improve safety at sea as well as to foresee new types of accidents.

Look at the aircraft industry!

Building the unsinkable ship is a dream, which will not be fulfilled; similarly it is impossible to build an aircraft (heavier than the displaced air) that cannot crash. But we can learn from the aircraft industry, which designs and builds aircraft so that the probability for a crash is very low and

continuously makes efforts to improve safety. This is achieved by choosing and carefully evaluating system designs and by having operating routines that ensure a safe operation.

Another important factor here is the response to accidents in order to remedy the causes – technical or operational – as fast as possible for all aircraft of that class, thus no grandfather clause! A similar design and operating philosophy for ships could mean a large step towards achieving improved safety at sea.

If we set as a goal that the probability for a ship accident should be as low as in commercial aircraft operations, the implication would be that we have to revise not only the design procedures but also the operating procedures. It can also be formulated as: 'How is the entire system managed to ensure a safe operation?'

More important than rules and technology

What can be done? First we have to realise that focusing on technical systems and rulemaking will not be enough, there have to be other approaches. The main point is to implement a different safety culture in shipping. We have already seen the introduction of the ISM code, which was a first important step. The danger as regards the ISM code and other rules is that there is a tendency of minimum fulfilment (just pass the inspection) and a vague understanding of who is responsible for implementation and compliance. This shows that two important changes have to be made



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- The purpose and the effect of the rules must be clear; otherwise real acceptance will be low.
- The responsibility must be crystal clear.

Someone must be responsible

Starting with responsibility, it could seem almost self-evident that the operator is the one who has the main responsibility. However, this clear-cut view on the operator's responsibility is in many cases obscured by bringing in the responsibilities of other parties, such as classification societies, maritime inspections, cargo owners etc. All this ends up in no one being responsible! (By operator we mean the company, or the body, who operates the ship and not only the people on board, who are responsible for hands-on day-to-day operations.)

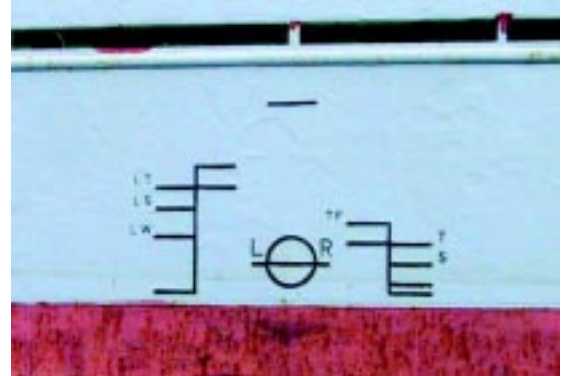
The second chance syndrome

Most people are aware of the severe and fatal consequences of aircraft accidents. This awareness is an important driving force in all air safety work, which is fully focused on the development of preventive measures to avoid incidents and fatal accidents. However, in sea transportation the general notion is that an accident is not ultimately fatal. There is a second chance! After a severe accident, e.g. grounding or fire on board, the operator and the industry may use their second chance. Put life jackets on and all passengers in lifeboats! Some people may think that when all these measures are activated, it is no longer a matter of maritime safety but complex rescue operations. The second chance syndrome: the expectation that it is possible to evacuate, often obscures the priorities in the safety work.



For aircraft, a number of errors and disturbances can be identified and quantified during a flight – more than 300 during 100 flights. Thanks to human action a very small fraction of these develop into an accident. This is achieved by focussing on education, training, and experience. The incident reporting and blame-free culture play an important part here.

A similar process of identifying and quantifying errors and disturbances in ship operations would be an important step to improve maritime safety.



The freeboard mark was made statutory in the UK in 1876, after agitation from Samuel Plimsoll – and consequently the mark is often referred to as Plimsoll mark. The introduction of the freeboard mark can also be said to be the first important rulemaking to enhance safety at sea.

PHOTO BY COURTESY OF ADVOKATFIRMAN IHRE AB

It is important to focus on what the first chance can offer: safe operations, the possibility to stay on board, and safe ports. The ship is the best lifeboat! This means that rulemaking should focus more on preventing accidents and less on mitigating the consequences.

The positive factor – the human being

A common explanation for the occurrence of many accidents is the human factor. Strictly speaking all accidents are consequences of human action, from the design and building of the ship to the operation of the ship. We would instead prefer to look at human actions as factors in avoiding accidents. All systems will experience malfunctions as well as disturbances from outside, and if the people on board do not know how to handle these, they might develop into an accident.

Thus the question is instead how can we strengthen the human factor. The obvious answer is education, training and experience. As regards experience, an important part is learning from others' experiences, and that is why we think it is so important to incorporate incident reporting combined with what is known as a blameless culture into the shipping world.

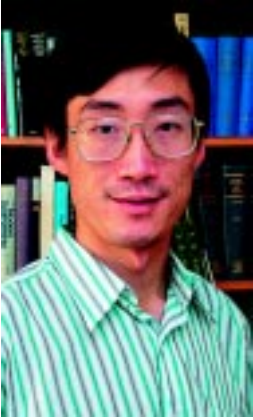
Improving safety at sea

There are a lot of measures to improve safety at sea. It is our conviction that a change in attitude is needed, including clear-cut responsibilities and an understanding that today's shipping is working in an environment – technologically, economically and socially- which is very different from that of the 19th century.

An interesting exercise might be to develop a safety regime, which is based on today's ship designs and available technology.

Willem B van Berlekom / Jim Sandkvist

Safer port operations through new research into bank effects



Da-Qing Li, project manager & researcher. He received his B.Sc. in Naval Architecture from Huazhong Univ. of Sci. & Tech. in China in 1986 and his Ph.D. in hydrodynamics from Chalmers Univ. of Tech. (CUT) in Sweden in 1994. He worked as post-doc at CUT 1995-1997. Employed at SSPA since 1998, he has been working with propeller/waterjet propulsion, cavitation/erosion, shallow water problems and model-testing/CFD methods for solving these problems. Telephone: +46 - 31 772 9053 E-mail: da-qing.li@sspa.se



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According to the National Maritime Administration's statistics, 13% of the total collisions between ships in Sweden in 1999 occurred in harbours. Of the total number of collisions between a ship and other structures, 36% occurred in harbours. There are indeed risks in harbour manoeuvres.

The causes are well known – the interaction between the ship, the environment, and other ships in shallow and constrained waters like harbours and canals often causes difficulties and, even worse, accidents. Squat is one interaction phenomenon in shallow water, which causes trim and sinkage of the ship.

Another interaction phenomenon, when a ship manoeuvres close to the shoreline or a quay wall, is the so-called *bank effect*. Due to bank effects the ship experiences a lateral force and a turning moment, the latter normally providing large heading deviations. In a narrow canal this might even lead to a collision with the bank or with an approaching ship, if not properly handled.

New trends in maritime transportation

In the past it was believed that only low-speed displacement ships (e.g. tankers) would encounter serious bank effects. Research was thus focused on this type of ship. However, several new trends have come into play since then:

Building fast ships of ever-increasing speed means that bank effects also occur with *high-speed* ships.

The increase in vessel size reduces the margin between the ship and the bank. Namely, ships are being

operated more often under such conditions as would have been considered as extreme conditions 30 years ago. For example, operating a ship in shallow water with a keel clearance of 10% of draught is not unusual nowadays.

The increase in the traffic density in harbours also results in smaller margins between ships as well as between ships and banks.

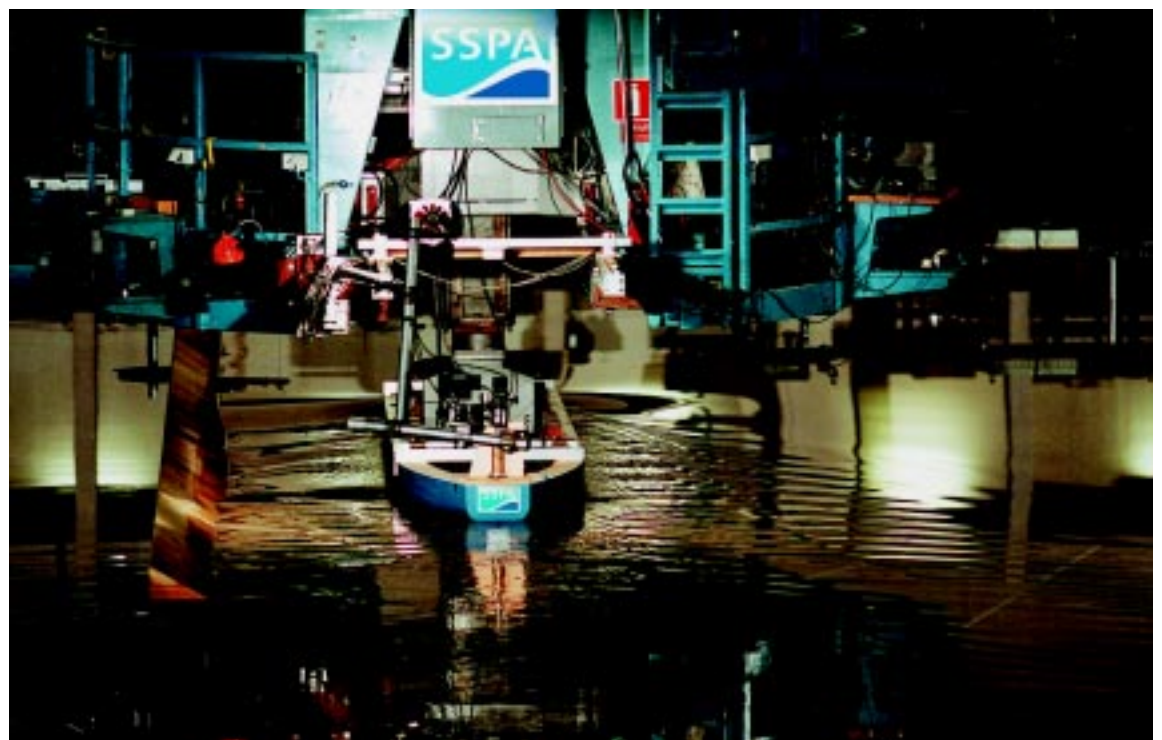
Last but not least, the increasing concern about safety in transportation has put higher demand on more rigorous control of ships in harbours.

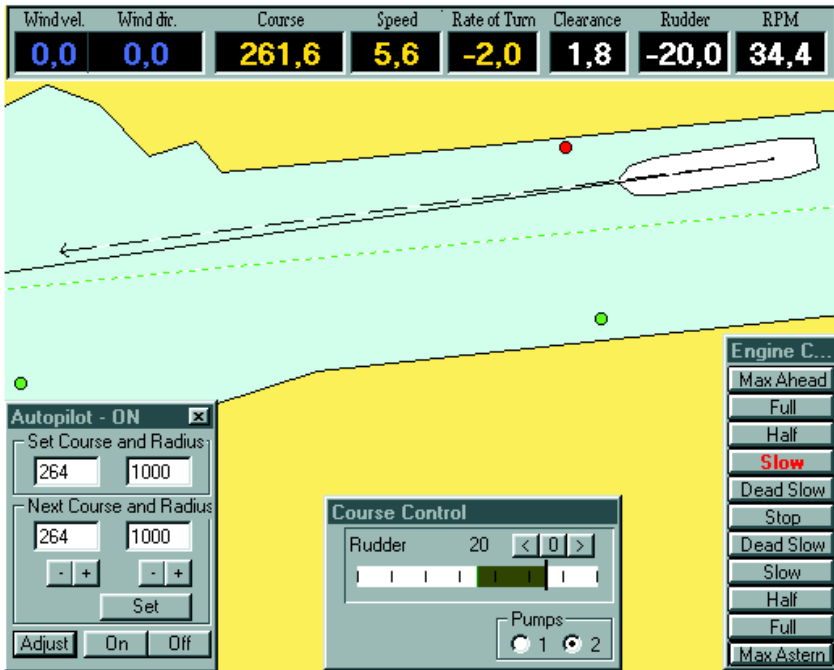
How to manoeuvre and operate a ship safely in constrained waters like harbours or narrow fairways has therefore become an essential concern today.

Research at SSPA to find remedy

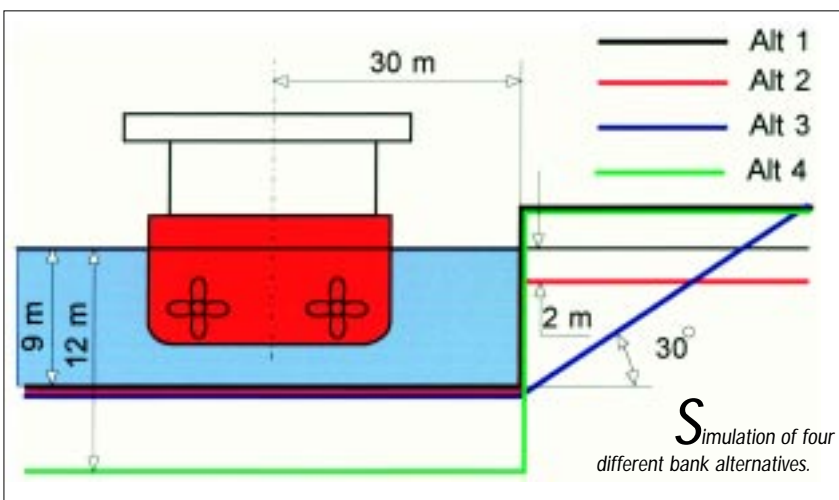
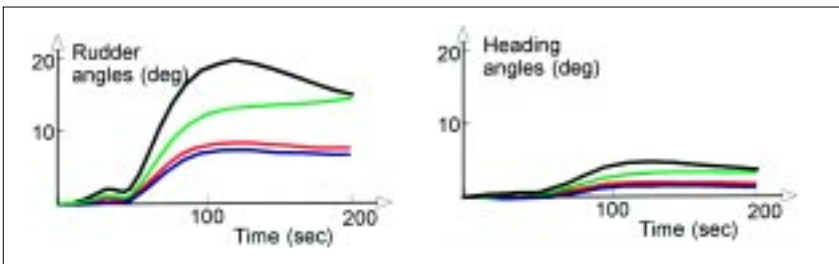
It was realised that further understanding of bank effects is vital to manoeuvring modern ships in a bank passage; a research project was thus initiated at SSPA. The project included systematic experiments, development of new mathematical models, and some theoretical investigations using CFD. The experiments were focused on measuring the side force and the turning moment, but wave eleva-

The deep wave troughs beside the tanker are the Bernoulli waves (Daniel Bernoulli, 1700-1782, a Swiss mathematician). Bernoulli waves always follow with the ship and are negligible in deep open water, but they are substantially magnified for displacement ships during a bank passage in shallow water, causing a significant disturbance to the bank or a nearby ship.





Simulations have a number of significant advantages: Offering professional training for ship operators; allowing for a wide range of parametric studies for performance evaluation; independence of weather; a training process can be repeated, recorded and played back; with the help of simulation, one can learn from an 'accident' in a 'safe' environment without being virtually subjected to the incident. The PORTSIM picture shows a tanker passing a bank on the starboard side. It is controlled by an autopilot. Note the starboard rudder counteracting the bow away turning moment caused by the bank.



Simulation of four different bank alternatives.

tions were also measured to study wave patterns during the bank passage. The new mathematical models were implemented in SSPA's simulation program.

A few results are mentioned here:

The side force and the turning moment are not always proportional to the speed squared. A more complicated relation may exist in shallow water and at high speeds.

If the water depth is not so shallow, say $h/T > 1.2$, the ship is normally subjected to a suction force and a bow away moment. To keep the course and to avoid any possible collision with the bank, a drift angle away from the bank and a rudder angle towards the bank side must be set by the operator to counteract the bank effect.

If the ship is passing a bank in very shallow water (e.g. $h/T < 1.15$) and is close to the bank, the side force becomes a repulsive force pushing the ship away from the bank. Both the side force and the turning moment can become surprisingly large in this case. A drift angle and a rudder angle, both towards the bank side, are needed to hold the course in this case.

Bernoulli wave becomes a dominant component for displacement ships in shallow water.

An example: Ro/Ro ferry along a bank of different shapes

In order to illustrate the behaviour in different bank situations, a 180 m long twin propeller/twin rudder ferry was simulated, when approaching and passing a bank of different configurations. Four different bank alternatives were simulated using PORTSIM (see below).

For each bank configuration, the ship passed the bank at a distance of 30 m. The heading is maintained by use of an autopilot. The approach speed was in each case 10 knots. The diagrams below show time histories of heading and rudder angles.

As was expected, bank alternative 1 provided the most disturbances to the ship, with required rudder angles of about 20 deg together with a heading deviation of about 5 deg. With the bank submerged, the effect is significantly reduced. A water depth of 2 m on top of the bank reduced the effect to less than half.

Simulation of ship handling in harbours

The concern about the new trends in transportation and recent accidents has led to even stronger attention to the use of simulators for training and for performance evaluation of ship handling in harbours and other confined waters. PORTSIM is the tool used at SSPA for these types of activities.

Da-Qing Li / Peter Ottosson

Rolling while manoeuvring Wanted: your experiences



Peter Trägårdh, Project Manager at SSPA. He graduated (M. Sc. in Naval Architecture) from the Royal Institute of Technology, Stockholm, in 1971 and has since then, except for six years at Öresundsväret, Götaverken Arendal and MariTerm, been employed at SSPA, mainly working with ship manoeuvring and seakeeping. He has been a member of ITTC Manoeuvring Committee since 1999. Telephone: +46 - 31 772 9044 E-mail: peter.tragardh@sspa.se

Sometimes the rolling behaviour of ships seems to have a large impact on the manoeuvring performance, although no full-scale experience of this phenomenon is known to the author. Maybe ships are not operated at the critical conditions tested, or the operator avoids manoeuvres that make the ship heel excessively. Or could it be that a ship owner does not want to talk about this kind of problem?

Nevertheless it is important that we are aware of this phenomenon and try to avoid any hazards because of it. An analysis of a number of manoeuvring tests with free-sailing models carried out in SSPA Maritime Dynamics Laboratory reveals interesting relations regarding roll motion in turning and zigzag tests.

Different types tested

Different types of ships such as cruising vessels, LNG carriers and Ro-Ro vessels (both single- and twin-screw) were included in this study. In total, 19 test conditions (with different combinations of ship type, approach speed, or metacentric height GM) have been studied. The maximum roll angles in standard turning and zigzag tests are plotted versus different ship parameters.

Roll angle: 28°!

In the most extreme case the maximum roll angle was 26° and the corresponding overshoot 60° at the 20/20° zigzag test. A quite strange behaviour was observed at the standard turning test with pull-out. The maximum roll angle was about 28°, and when the rudder was put amidships for the pull-out, the yaw rate and roll angle were first decreased but then increased as speed was picked up.

The test had to be stopped before steady state was reached due to restrictions of test area. The roll angle was then about 20°, and both roll angle and yaw rate were increasing.

Trying to identify the main factor

The first thought was that the GM would be the most important factor, and this is obvious from the diagrams below. However, speed, vertical centre of gravity, and roll moment of inertia should also be significant parameters, and some trend with respect to overshoot angle and tactical diameter versus roll angle could be expected.

Differences in hull form giving unusual GZ-curves were investigated, but they do not explain the roll behaviour. However, when the overshoot angle was plotted versus length over beam ratio (Lpp/B), an interesting trend was found.

Continuing by plotting the roll angle, divided by the Froude number ($Fnl = \text{approach speed} / (g \cdot Lpp)^{1/2}$) squared versus the Slenderness ratio times the GM/VCG ratio, the results became relatively concentrated along a curve. Slenderness ratio is defined as $Lpp / (\text{Displacement})^{1/3}$ and is similar to the Lpp/B ratio but gives a less scatterly pic-

ture.

How can this behaviour be explained and what is the significance in terms of course stability and manoeuvrability? Does a low Lpp/B or slenderness ratio mean a low righting moment even if the GZ curve is normal? Thus the heeling moment due to the turning would give a larger roll for shorter or less slender ships. Or could it be the wave pattern along the shorter ship that results in loss of stability?

From calculations into reality

Thus a ship's rolling behaviour may be estimated by calculating the ship's slenderness ratio, multiplying by the actual GM/VCG ratio, picking the corresponding Roll max / Fnl / Fnl value from the diagram at the bottom of the next page and multiplying by the actual Froude number (approach speed) squared. If the calculated roll angle is larger than 10° this would give a valuable indication of a possible problem.

A large overshoot in combination with the increasing yaw rate at the pull-out means a considerable degree of course instability. A large roll angle in these situations contributes to the poor course stability and vice versa. Further, a large roll angle, say in excess of 10°, should be a problem with respect to the safety of crew, passengers and cargo. Shifting of cargo due to large heel may in the worst case lead to a disaster with loss of lives and ship and environmental damage.

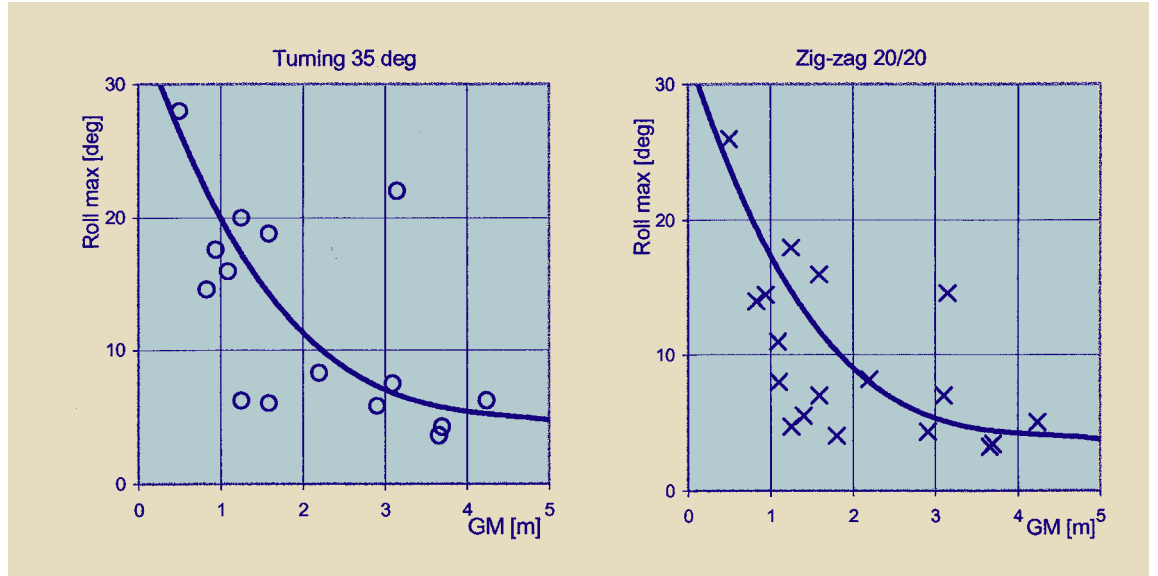
As mentioned no full-scale experience of this phenomenon is known to the author. Thus any comments from readers would be most welcome!

Peter Trägårdh

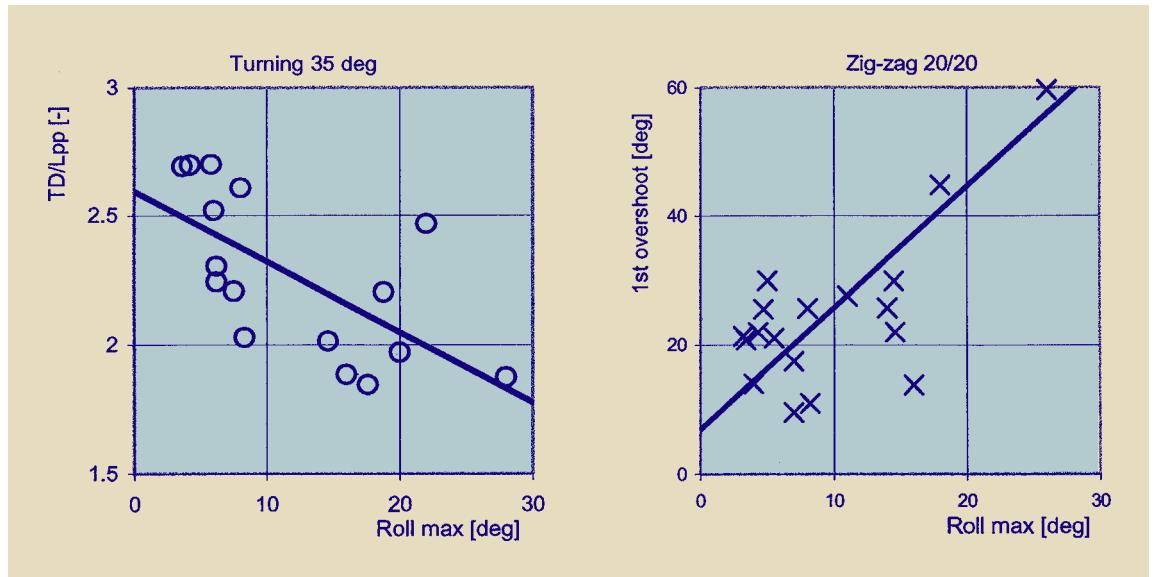


Ships can heel more than this one even in calm weather at certain manoeuvres.

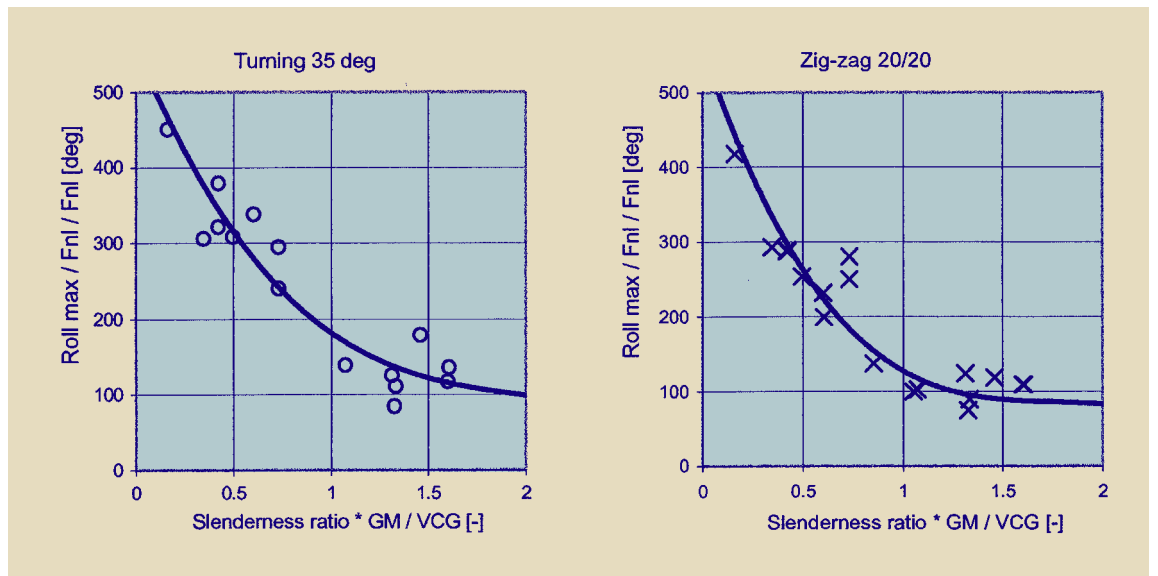
M_{ax} roll angle in turning and zigzag tests plotted versus metacentric height GM. Trend curves indicated.



T_{tactical diameter} and overshoot angle in turning and zigzag tests plotted versus ship length to beam ratio (Lpp/B). Trend lines are indicated.



M_{ax} roll angle in turning and zigzag tests plotted versus the non-dimensional slenderness ratio *GM/VCG. Trend curves are indicated.



Short comments

Simulator sales in the Göteborg area

SSPA has delivered the ship manoeuvring simulator PORTSIM to the Port of Göteborg.

At the introduction and training course, the Port of Göteborg was represented by the deputy harbour master Christer Ljunggren and the Swedish Maritime Administration by master mariner Tom Christofferson.

The simulator covers ship models from small container/RoRo ships up to 350 m VLCCs. Most of the existing port areas in Göteborg are modelled as well as some of the areas in future port plans.

The simulator will be used for feasibility port studies and for pilot training.

Lindholmens Gymnasium (Secondary School) has purchased an education package including three different simulators: PORTSIM, Cargo Secure and SeaVision.

PORTSIM will be used for basic nautical training, Cargo Secure for simulation of the dynamic lashing forces on board a sea-going ship, and SeaVision for teaching basic static or dynamic stability. In SeaVision it is possible to show, for example, how the influence of water on deck or icing affects the stability of the ship.

The simulator will be used by master mariners Jan Coxner and Gunnar Agnesson for classroom teaching and by the students in the ship technique classes for different simulation exercises.

This education package or part of it has earlier been delivered to Tønsberg's Maritime College in Norway, Finland's Fishery School and World Maritime University in Malmö, Sweden.

Thorsten Thostensson

Mid-term assessment for the 5 MEuro project OPTIPOD was held at SSPA in June. The project is proceeding very well, as can be judged by all the happy faces on the picture. Results from extensive studies on a 29-knot podded ROPAX are now available to the consortium, and the project will continue by studying a cruiser, a supply ship and a chemical tanker. The goal of the project is to create guidelines for the design of podded ships.

Propulsor development for the Italian Navy

Whitehead Alenia Sistemi Subacquei S.p.A. (WASS) has commissioned SSPA to carry out development of the propulsor unit as well as development of a manoeuvring simulation model for the Black Shark torpedo. To support the development work SSPA has carried out model tests including captive manoeuvring tests and cavitation tunnel tests.

The Black Shark torpedo is being developed for the Italian Navy and will, according to WASS's spokesman, be 'a real future torpedo able to cope with even more demanding requirements and designed for easy integration into submarines and combat systems'.

Lennart Byström / Per Lindell



Safety and risk analysis within OPTIPOD

The IMO (International Maritime Organization) Formal Safety Assessment (FSA) will be used to assess the need for any regulatory steps in safety and risk control connected with pod driven ships. FSA is a systematic approach to assessing risks associated with shipping activities and for evaluating the costs and benefits of measures to prevent or

Ph.D. Thesis

Jonas Waidringer at SSPA Research is presenting and defending his doctoral thesis 'Complexity in transportation and logistics systems. An integrated approach to modelling and analysis' at Chalmers University of Technology for the Degree of Doctor of Philosophy on the 14th of September, 2001. Faculty opponent is Prof. Peter Allen, Complex Systems Management Centre, Cranfield School of Management, England.

The basis for the thesis is to assess the usefulness of describing and analysing transportation and logistics systems as being complex systems. Four empirical studies representing four different aspects of transportation and logistics systems are used as a base for the analysis: terminals, supply chains, distribution channels, and the transportation of passengers.

Claes Källström

Research seminars

SSPA has, together with Chalmers University of Technology, Göteborg, and the Royal Institute of Technology, Stockholm, started up a series of seminars in order to present research projects and results within 'Waterborne Transport and Ship Technology'. Swedish maritime industries and organisations are invited and the goal is to transfer knowledge and experiences from EC-funded and national research projects in a usable way.

The first two seminars were

reduce such risks.

The FSA process carried out within the OPTIPOD project will be an expert survey approach led by SSPA. A seminar and workshop with the experts in Europe will be part of the assessment. The FSA will cover overall operational aspects of the ship, focussing on safety aspects in connection with manoeuvring and power redundancy.

Karin Magnusson



successfully held in the spring of 2001 with the titles 'Safe Waterborne Transport' and 'Human Factors and Technology in Shipping'. Two new seminars will be given on September 13 and October 25: 'Environmentally Friendly Waterborne Transport' and 'New Ship Technologies'. More information can be found on www.sspa.se. The seminars are given in Swedish.

Claes Källström

Urban planning in Vilnius

SSPA has been contracted to support the Vilnius City Municipality in the physical planning and development of the Uzupis and Paupys neighbourhoods, which have been considered priority areas of the city.

The international importance of Vilnius Old Town has been recognised by its inclusion on UNESCO's World Heritage list in 1994. The Old Town of Vilnius is one of the largest historic areas in Europe. It is here important to ensure the balance between heritage conservation and urban development objectives.

The Uzupis area was developed as an eastern suburb settlement of Vilnius at the end of 16th century and was mainly inhabited by Russian and Belarusian merchants. The area has been worn down during a long period and lacks proper infrastructure today. The Paupys area is an outdated industrial area, which needs improvement.

Per Danielsson

Please visit our web site!
www.sspa.se

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